Mineralogy and Stratigraphy of Polygenetic Soils on Different Geomorphic Surfaces of the Bluestem Hills of East Central Kansas

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Introduction

East central Kansas is largely comprised of alternating, level beds of Permian shale and limestone. Upland soils in this region have a complex genesis, often contain one or more paleosols, and form in multiple parent materials including loess, colluvium, residuum, and old alluvium. The depth to bedrock rarely exceeds 2 m. The ages of the parent materials are often undetermined and debated. The series of interest include the Irwin series which is mapped on interfluves and benches as well as footslopes and paleoterraces and these soils classify as fine, mixed, superactive, mesic Pachic Argiustolls. The Ladysmith series is also mapped across a range of upland landscape positions, and these soils classify as fine, smectitic, mesic Udertic Argiustolls.

Objective

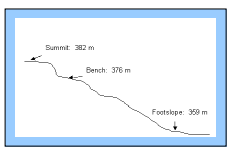
To determine the mineralogy, genesis, parent materials, and absolute ages of polygenetic soils that span geomorphic surfaces.

Site and Methods

The study area is located in the Lower Cottonwood River watershed in the Bluestem Hills Major Land Resource Area in eastern Chase County, Kansas. Three soil pedons were sampled with a truck-mounted soil probe and described. Three horizons per pedon were selected for clay mineralogical analysis using X-ray diffractration spectometry. One horizon per pedon was selected for radiocarbon dating. Accelerator mass spectroscopy (AMS) dating and isotopic analysis was performed by the Isotope Geochemistry Laboratory at the Illinois State Geological Survey.

Left: Bench pedon

Right: Site diagram



Results

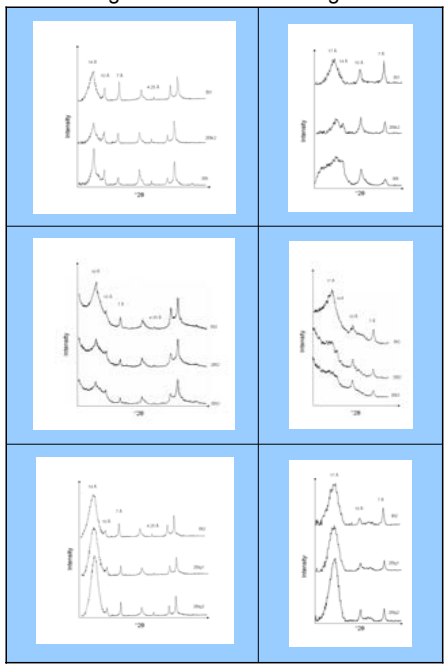


Table 1. Summit pedon 06KS017002. Elevation: 382 m.

Depth (cm)	Parent Material as Described in Field	Horizon	Age[1] (RCYBP +/-)	Field Description of Clay Films	Abundance of clay minerals (Semi-quantitative)
40-55	Loess	Bt1	ND	5%, faint, discontinuous	25% Illite, 45% Smectite, 30% Kaolinite
116 – 143	Colluvium	2Btk2	ND	1%, faint, continuous	30% Illite, 20% Vermiculite, 30% Smectite, 15% Kaolinite
169-180[2]	Colluvium	3Bt	22,490 +/- 90	25%, faint, continuous	30% Illite, 20% Vermiculite, 30% Smectite, 10% Kaolinite

[1]RCYBP = Radiocarbon years before present. ND = Not determined.
[2]Material dated was from 143-152 cm.

Table 2. West bench pedon 06KS017011. Elevation: 376 m.

Depth (cm)	Parent Material as Described in Field	Horizon	Age[1] (RCYBP +/-)	Field Description of Clay Films	Abundance of clay minerals (Semi-quantitative)
35-51	Loess	Bt2	ND	5%, faint, discontinuous	20% Illite, 50% Smectite, 25% Kaolinite
83 – 99	Colluvium	2Bt2	ND	25%, faint, continuous	30% Illite, 15% Vermiculite, 20% Smectite, 20% Kaolinite, 10% Interstratified 2:1
99 – 138[2]	Colluvium	3Bt3	24,490 +/- 120	50%, faint, continuous	30% Illite, 15% Vermiculite, 20% Smectite, 20% Kaolinite, 10% Interstratified 2:1

[1]RCYBP = Radiocarbon years before present. ND = Not determined.
[2]Material dated was from 99-138 cm.

Table 3. Footslope pedon 05KS017003. Elevation: 359 m.

Depth (cm)	Parent Material as Described in Field	Horizon	Age[1] (RCYBP +/-)	Field Description of Clay Films	Abundance of clay minerals (Semi-quantitative)
41-55	Loess	Bt2	ND	2%, faint, patchy	20% Illite, 55% Smectite, 20% Kaolinite
100-130[2]	Colluvium	2Btg1	19,030 +/- 60	10%, faint, discontinuous	25% Illite, 55% Smectite, 15% Kaolinite
165-200	Colluvium	2Btg2	ND	5%, faint, discontinuous	20% Illite, 65% Smectite, 15% Kaolinite

[1]RCYBP = Radiocarbon years before present. ND = Not determined.
[2]Material dated was from 142-170 cm, directly below stone line.

Conclusions

•In the summit and bench pedons, the mineralogy of the modern soil and upper paleosol is dominated by smectite, while the lower paleosol has a more mixed mineralogy containing approximately equal amounts of clay mica, vermiculite, smectite, and kaolinite.

•In the footslope pedon, all horizons are dominated by smectite, in quantities estimated at 55 to 65% of the clay fraction. Illite and kaolinite were present and content ranged from 15 to 25%. No vermiculite was present in the terrace pedon.

•Numerical ages for upland paleosols ranged from ≈20,000 to 22,500 to 24,500 RCYBP for the upper and lower paleosols, respectively. These dates indicate when the paleosols were buried by new sediments.

•The lowest, well-developed paleosol (summit and bench only) is likely the Sangamon paleosol formed in colluviated Loveland loess. For all three pedons, the upper paleosol correlates to a colluvial lithofacies of the Gilman Canyon Loess Formation, recently termed the Severance Formation (Mandel and Bettis, Geological Society of America Abstracts, 2003).

•Differences in mineralogy between the stratigraphic units may be inherited from the parent materials, or arise from pedogenesis.

•High smectite content throughout the footslope pedon is likely from pedogenesis as the age is similar to the other pedons. Although the stratigraphy appears similar, there could be differences in the source of the colluvium for the footslope pedon.

•Results from this study will be provided to the USDA-NRCS for use in future soil survey updates.

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